portion of the coil at point **408**, along with a detachment apparatus (not shown). It serves only to assist in the detachment and does not function as a permanent member of the device within the tubular structure (e.g. blood vessel). Since the detachment apparatus is completely separate from the "coil", re-use of the detachment apparatus on multiple coils is possible. In this particular device shown, the detachment apparatus would have a loop on the end which would engage a hook on the proximal part of the coil, pulling it back into the catheter to the point where the detachment portion was near the end of the catheter. When the coil then was introduced to the detachment point, further retraction on the detachment apparatus core would cause detachment of the proximal from the distal component of the intravascular device.

The most immediately obvious application of this device is its use to occlude large vascular lumens which require placement of multiple currently commercially available coils. Other applications may ensue to occlude lumens of other tubular structures, such as veins or fallopian tubes. No currently available coil acts via an immediate, completely occlusive action as it is the case with this intravascular device. Detachable balloons are the most analogous in that regard, but their construction and method of use is radically different from that of the umbrella intravascular device. Specifically, balloons do not create thrombosis upstream from their location.

The materials from which the distal element are constructed need not be limited. For some applications, filaments of synthetic materials may be more appropriate for use as the skeleton fibers, owing to increased structural integrity, flexibility or stiffness, or other physical qualities which those materials may impart. For other applications, metallic wire may be applicable. Currently, wires of stainless steel, platinum, tungsten, and gold and other devices of cobalt and other metals are used in medical applications. Factors such as strength, flexibility, or bonding to the other elements may favor one metal over another also.

The attachment of the elements to one another will be a function, to some extent, of the desired application. In some instances, a more rigid web of material may be desired to bridge between expansion members. In other instances, a more flexible attachment may be desired in order to allow the umbrella to collapse more completely or to navigate more tortuous tubular channels.

Attachment of the elements to one another may be achieved by solid or mechanical means. Solid attachment may be achieved by use of solder or glue materials or by melding or fusion of the two (welding or melting one to the other). Alternatively, a collar of wire or other material may be used to connect fibers to each other or to connect the skeleton to the material forming the umbrella.

The distal, occlusive element is anticipated initially to be connected to the proximal element by at least one connecting wire or fiber such that the distal element is carried a short distance distally. Using a detachment system for introduction, the presence of the connecting fiber would allow a loose placement of the umbrella from the introducer, thus allowing the physician performing the placement to test the stability of the deployment and to assure that the risk of embolization of the device is minimal -prior to ultimate detachment and permanent placement. Thus, the connecting fiber and attaching coil combination allow assurance that the occlusive umbrella element is stable in its placement prior to withdrawal of the introducer and detachment apparatus.

The lead and trail elements can be coils as described above. Typically, if coils are used, the deployed coils can be

stainless steel coils, larger platinum coils, or coils constructed of nonmetallic materials proximal to the umbrella component. These may be desirable to enhance the detachment or stability of placement of the device. This modification of the deployable coil may permit utilization of materials which are designed to maximize thrombosis or achieve some other therapeutic aim such as vascular sclerosis.

As with earlier embodiments, utilization of the umbrella intravascular device will most frequently occur via a transfemoral catheterization, either arterial or venous. An angiographic catheter (referred to in FIG. **2** as catheter **8**) will be placed such that its tip is near the desired deployment location. In some cases, this will involve a coaxial catheterization. For instance, in cerebral embolizations it is common to place an introducer catheter from the femoral approach into the carotid or vertebral artery. From there, a second smaller catheter is inserted by way of the angiographic catheter and advanced to a point within the brain near the pathology, and the embolization is conducted through this smaller catheter. In these situations, that smaller catheter becomes the introducer catheter for purposes of this application, since it is the most distally placed catheter through which the device will be introduced.

Following angiographic verification of placement of the introducer catheter, the system will be introduced into the hub of the introducer. It is anticipated that an assisting device for the introduction of the system will be necessary, as described above. Again, however, different designs to achieve this are possible and the design of the assisting device is not critical to this application. Following introduction, the coil is advanced within the introducer until it can be seen under fluoroscopy to be exiting the introducer. If it is a free-standing coil, its exit from the introducer catheter will result in final placement. If it is a detachable device, when the device is observed to have exited the introducer completely and to lie in an appropriately stable position and configuration, the detachment is performed.

Although preferred embodiments of the invention have been described in the foregoing Detailed Description and illustrated in the accompanying drawings, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications, and substitutions of parts and elements without departing from the spirit of the invention. Accordingly, the present invention is intended to encompass such rearrangements, modifications, and substitutions of parts and elements as fall within the scope of the invention.

I claim:

1. An intravascular device for use with a catheter having a detachment apparatus, said device comprising:

at least one lead element; and

a trailing element detachably interconnected to at least one said lead element, said trailing element adapted for attachment to said detachment apparatus;

wherein said at least one lead element is structured to cause occlusion of a vessel.

2. The intravascular device of claim **1**, wherein said at least one lead element comprises a material capable of producing thrombosis.

3. The intravascular device of claim **1**, wherein said at least one lead element comprises an expansible element.

4. The intravascular device of claim **1**, wherein said at least one lead element comprises a particle.

5. The intravascular device of claim **1**, wherein said at least one lead element comprises a coil.

6. The intravascular device of claim 1, wherein said trailing element is chemically detachable from said at least one lead element.

7. The intravascular device of claim 1, wherein said trailing element is mechanically detachable from said at least one lead element.

8. The intravascular device of claim 1, wherein said at least one lead element functions as an anchoring element.

9. The intravascular device of claim 1, further comprising a fiber detachably interconnecting said at least one lead element and said trailing element.

10. The intravascular device of claim 1, wherein the end of said detachment apparatus has the shape of a loop, and wherein said trailing element comprises a hook adapted to engage said loop.

11. The intravascular device of claim 10, wherein said at least one lead element comprises a coil.

12. An intravascular device comprising:

at least one lead element;

a trailing element; and

a fiber detachably interconnecting the trailing element to said at least one lead element;

wherein said at least one lead element is capable of causing occlusion of a vessel.

13. The intravascular device of claim 12, wherein said at least one lead element comprises a material capable of producing thrombosis.

14. The intravascular device of claim 12, wherein said at least one lead element comprises a coil.

15. The intravascular device of claim 12, wherein said at least one lead element functions as an anchoring element.

16. An intravascular device for use with a catheter having a detachment apparatus, said device comprising:

at least one lead element;

a trailing element; and

a fiber detachably interconnecting the trailing element to said at least one lead element;

wherein said at least one lead element is capable of causing occlusion of a vessel, and wherein said trailing element is adapted for attachment to said detachment apparatus.

17. The intravascular device of claim 16, wherein said at least one lead element comprises a material capable of producing thrombosis.

18. The intravascular device of claim 16, wherein said at least one lead element comprises a coil.

19. The intravascular device of claim 16, wherein said at least one lead element functions as an anchoring element.

20. The intravascular device of claim 16, wherein the end of said detachment apparatus has the shape of a loop, and wherein said trailing element comprises a hook adapted to engage said loop.

21. The intravascular device of claim 20, wherein said at least one lead element comprises a coil.

* * * * *